U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-283 693

A System for Tannery Effluent Treatment

A.C. Lawrence Leather Co, Inc, Hazelwood, N C

Prepared for

Environmental Protection Agency, Washington, D C

19 Jun 78

PB 283 693

A SYSTEM FOR TANNERY EFFLUENT TREATMENT

By

LAWRENCE K. BARBER
A. C. LAWRENCE LEATHER COMPANY, INC.
DANVERS, MASSACHUSETTS
WINCHESTER, NEW HAMPSHIRE
U.S.A.

Presented to

THE AMERICAN LEATHER CHEMISTS
ASSOCIATION
CONVENTION 1978
LAKE PLACID, NEW YORK

June 19, 1978

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

This project has been financed in part with federal funds from the Environmental Protection Agency under grant number S804504. The contents do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names of commercial products constitute endorsement or recommendation for use.

A SYSTEM FOR TANNERY EFFLUENT TREATMENT

Some tanneries are fortunate enough to be located geographically or otherwise so that the inevitable impact of effluent pollution control is minimal. Others have to go the full distance and design, construct, and operate wastewater treatment facilities of their own, to meet State or Federally imposed discharge requirements. This we were required to do at one of our A.C. Lawrence tanneries. We have just completed a demonstration project for the U.S. Environmental Protection Agency on this system, in which the Agency supported the operation for a twelve month period, and during which a significant amount of data was accumulated, representative of both summer, and winter, operating conditions. I am using excerpts from the report on the E.P.A. project to describe that system to you today. Before going further I would like to acknowledge the aid and assistance of two consultants, Dr. E.R. Ramirez of Swift Environmental Systems, Chicago, and Dr. W.L. Zemaitis, P.E. of Envirobic Systems, Inc., New York. this paper contains some excerpts from material written by them as pertaining to their particular fields, Dr. Ramirez in the primary treatment phase, and Dr. Zemaitis in the secondary.

Introduction

Tanneries in general are pollution intensive industrial complexes, generating comparatively large volumes of high concentration wastewater which historically have been discharged into rivers and waterways without much, if any, attempt toward purification. This paper is intended to present the details of construction, and operating data, including analytical results, for a system which was designed to eliminate most of the objectionable components of a tannery effluent formerly discharged directly into a small river.

Tanneries are not all alike. The basic design of procedures for hide preparation, tanning and finishing vary rather widely according to the kind of raw hides employed and the characteristics desired in the finished leather product. Accordingly the U.S. Environmental protection Agency, in order to better understand the problems associated with pollution abatement, classified the various segments of the industry into seven categories. These are:

Category 1. Cattlehide - Pulp Hair - Chrome Tan
2. Cattlehide - Save Hair - Chrome Tan
3. Cattlehide - Non Chrome Tan
4. Thru-the Blue
5. Retan only
6. No Beamhouse Tannery
7. Shearlings

In this presentation the category is number seven, Shearlings.

I hasten to say, at this point, that I realize full well that all or most of you are not in the business of running a shearling tannery. Please do not immediately arrive at the conclusion that this does not apply to you. The principles employed are applicable to any tannery effluent as I will point out later on.

A " shearling: tannery is one which tans and finishes sheep pelts with the wool intact, thus producing "skins" which, except for alterations of character and appearance to accomplish permanent preservation, and enhance aesthetic qualities, are essentially the same entity as when removed from the parent animal. The pelts are received either green salted or dry salted in railroad cars or auto trucks from large scale meat producing points in the midwest, far west, or Atlantic seaboard. The pelts contain large amounts of animal grease and interfibrillary water soluble proteinaceous compounds in the form of glycomucins and the like, within the skin substance, as well as large quantities of lanolin, wool grease, and animal soil attached to or entrapped in the wool. These components are removed early in the processing procedure during washing operations, the grease and lanolin being coaxed into dispersal through the use of strong detergents and emulsifiers.

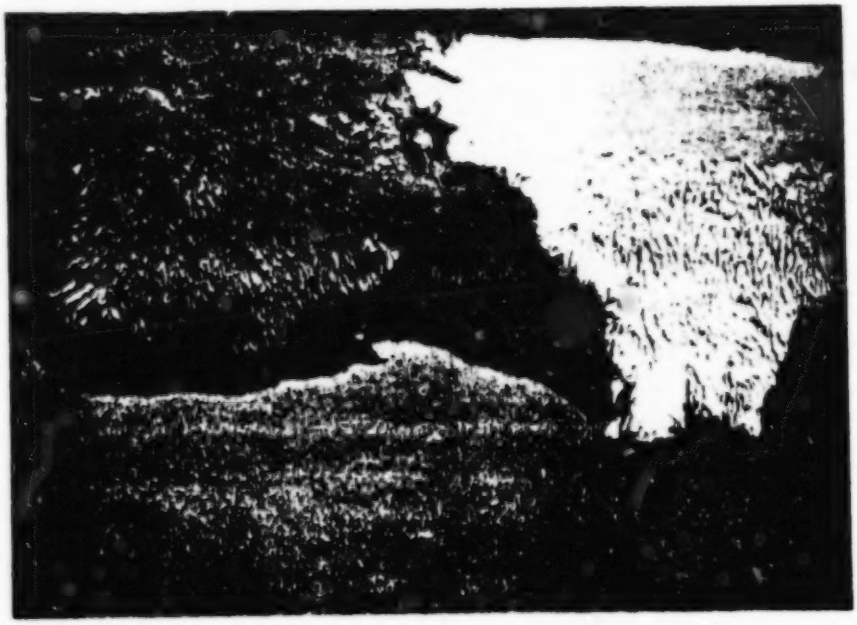


Plate I - Shearling as received and after washing

The wastewater treatment system selected for the Winchester Tannery and upon which this paper is based, was chosen, of course, from a number of options. The electrochemical primary system, sometimes called Lectriclear, was favored for several reasons:

1. The presence of large quantities of emulsified lanolin, wool grease, and animal fat, as well as spent fatliquor solutions, all well dispersed, dictated a clarification system which would involve flotation rather than gravity separation.
2. It was clearly demonstrated on a laboratory scale that the floated skimmings would have a much higher solids content, perhaps on the order of 10X, than a gravity system could deliver, and thus sludge storage, handling and dewatering would be expedited.
3. The continued flotation effect provided by the electrodes in the flotation basin seemed to be in the direction of maximizing primary clarification.
4. The electrolytic generation of chlorine coincident with the other products of elecrolysis appeared to be beneficial side effect that could be expected to provide some disinfection.
5. At the time of selection it was thought that reduction of ammonia was occurring within the Lectriclear system, and this was a possible plus. Later this was found to be untrue.

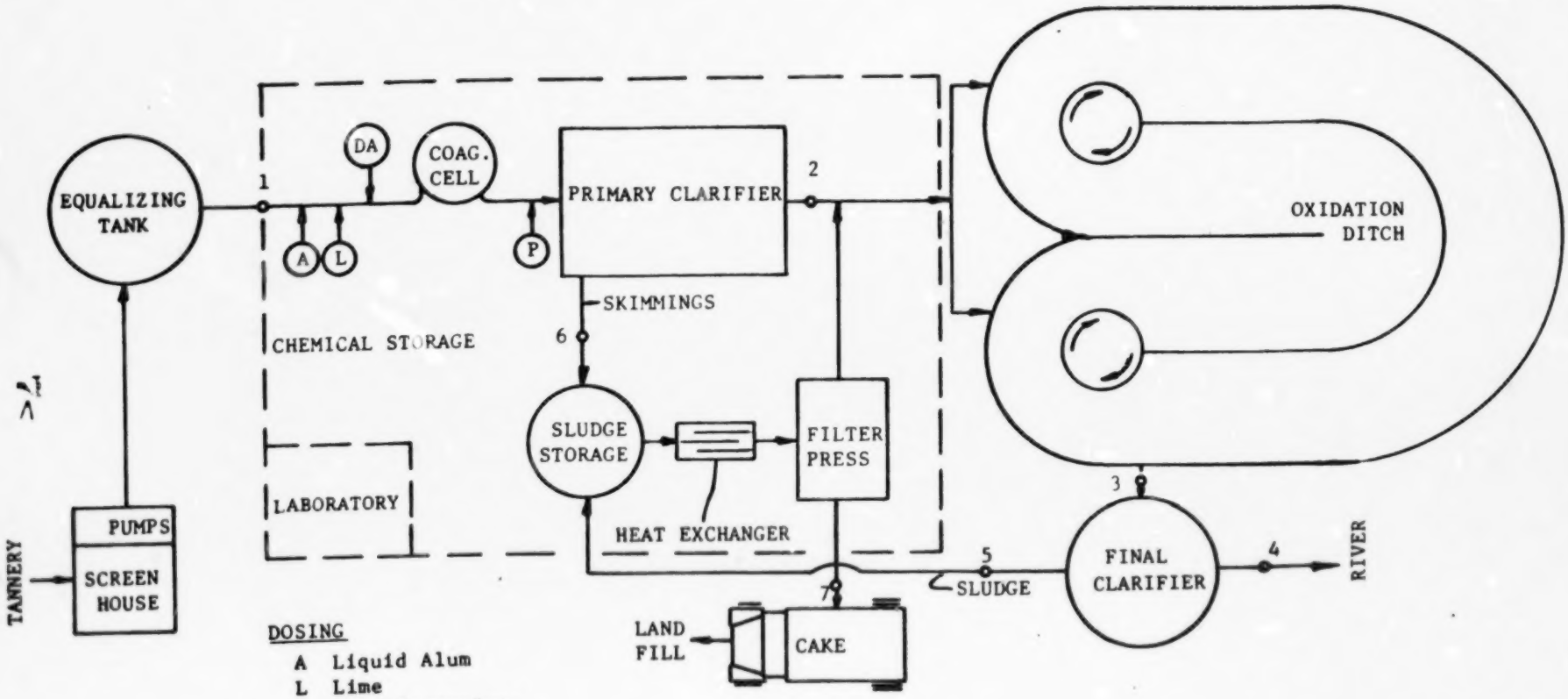
The secondary system was likewise selected from a number of possible choices. The Carousel concept was brought to our attention by E.P.A. and leather industry representatives who visited Holland in 1974. They reported rather enthusiastically as to the simplicity of design, low cost, and minimum land requirement, as well as adaptability to norhtern winter climate operation, ease of control of dissolved oxygen, and low operating cost. In addition, and most important, it was claimed to have the capability of not only nitrifying, but denitrifying as well. Because all of these factors seemed to indicate superiority over other known systems consultant help was secured and the decision made to install a Carousel unit.

The third essential choice involved the sludge dewatering device. Since land area on the tannery property is limited it was obvious that the solid waste from the treatment plant would have to be deposited at the regional solid waste management facility. Samples were submitted. The material was accepted with the

stipulation that the dry solids content would have to consistently reach 35-40%, preferably 40. Since we were aware of only one device which could reliably be expected to provide this performance it was not difficult to recognize the need for a filter press.

The choices made in assembling this treatment plant have proved to be wise. Consistent high degree removals of pollutants have been achieved, in most cases well in excess of discharge permit requirements. Ensuing sections will go into this in detail.

SCHEMATIC OF PRIMARY & SECONDARY TREATMENT SYSTEMS FOR WINCHESTER, NH



DOSING

- A Liquid Alum
- L Lime
- P Polyelectrolyte
- DA Dispersed Air device

SAMPLING POINTS

1 - Equalized Influent - to Primary Clarifier
2 - After Primary Clarifier - to Oxidation Ditch
3 - After Oxidation Ditch - to Final Clarifier
4 - Final Effluent - to River
5 - Final Clarifier Sludge
6 - Primary Clarifier Sludge
7 - Compacted Sludge

Characterization of Process Discharge

Shearling processing is a complex procedure using a much greater water to hide ratio than most tanneries. Since the wool is retained, and it is desired to keep the wool fibres as ttached to the pelts free from interweaving and tangling, the practice has developed to "swim" the skins in chemical solutions rather than limit the chemical floats to the smallest possible amount, as has become the practice in other categories of tanning operations. The liquor to skin ratio, by weight, for each fill and drain, is on the order of 2.5 to 1. With side leather the ratio is apt to be 1 to 1, and in some individual instances may be as little as 0.25 to 1. The Winchester tannery uses approximately 90 gallons of water per pelt, 7500 gals. per 1000 lbs of green salted weight as received, or, on a weight basis, a ratio of 60 to 1. This seems very high but is necessitated primarily by the extremely soiled condition of the pelts au naturel. The tannery processes some 3000 skins per day and discharges just under 300,000 gallons of wastewater per day.

All of the above operations are carried on at the ground floor level of the tannery, and the liquid contents of the paddle vats discharge by gravity to in-floor drains and sewers. This means that is is possible for a number of vats to be discharging dissimilar solutions to the wastewater collection system at the same time. Generally the soak waters are the first to be sewered in the workday, beginning about 3 a.m., and lasting until 3 p.m., the pickle liquors are dropped from about 11 p.m. to 11 a.m., tan liquors from 7 a.m. to 2 p.m., and color-fatliquor solutions from 7 a.m. to 3 p.m. This accounts for the equalizing tank at the front end of the wastewater treatment works, where not only the dissimilar solutions are blended, but surges in hydraulic flows are absorbed.

The blended waste stream is thus a complex mixture of organic and inorganic chemicals, tanning materials, both mineral and vegetable, mineral, animal and vegetable oils, both raw and solublized, and a spectrum of dyes. It is a murky brew at best, sometimes red, sometimes blue, usually dirty gray, but always bad, and a challenge to any sanitary engineer. A typical analysis of a compsite sample from the equalizing holding tank is as follows:

	mg/l
Suspended Solids	1295
$B.O.D._5$	840
NH_4-N	32
T.K.N.	78
F.O.G.	443
Cr.	109

While this analysis may not appear to represent contamination loads encountered at chrome side tanneries, it is not as different as one might expect.

Later in this report the subject of application of the treatment process described herein to chrome side production and veg tan effluent will be discussed.

Operation of the Primary Section:

The plant obtains about 90% of its water for processing from the Ashuelot River. Drinking water and certain limited plant processing steps use city water. Dumping of the water used for processing the pelts occurs between the hours of 3 a.m. and 7 p.m. A peak in hydraulic wastewater flow occurs at about 11:00 a.m. As the wastewater leaves the plant it is passed through a stainless steel cylindrical Stahling screen where some of the wool fiber is removed. From this point the water passes into a 3000-gallon pit and it is then pumped directly into the 160,000-gallon holding tank. Wastewater in the holding tank is lifted by an immersion pump and passes through a head box which provides the hydraulic head to feed the primary Lectroclear system. pH of the wastewater in the holding tank varies between 5.1 and 7.2. The head box is approximately 15 feet above the LectroClear operation. This hydraulic head provides a flow of about 300 gallons per minute and the wastewater flows by gravity from the headbox to and through the entire primary phase.

On leaving the head box (in a 10-inch pipe), 1000 mg/l of alum is added to the wastewater. At a distance of approximately 20 feet from the alum addition and just prior to the dispersed air device, 800 ppm of hydrated lime is added from a 10 weight percent lime slurry. Both chemical additions are added by metering pump manually set to a predetermined feed. The wastewater then passes through the dispersed air device, and the vortex coagulation cell for a dwell time of 2.2 minutes after which 12 mg/l of polyelectrolyte is added (X-400 Swift anionic polyacrylic acrylamide). At this point the pH is consistently between 7.5 and 8.5. pH is monitored frequently and deviations from the just-above-neutral zone are correctly by adjustment to the lime feeding mechanism.

It must be said here that it was and is the intention to control pH by automatic adjustment to lime feeding. Equipment was provided for this at the outset but thus far manual adjustment has not only been found to be adequate, but more reliable.

The system is designed ans an "on-off" operation. This "on-off" control is carried out by a float valve in the holding tank. When the water in the holding tank is above a predetermined level, the float valve keeps all pumps and power on, and conversely when off, all off.

Secondary:

The secondary, or biological reduction section, is much more simple in day to day operation. Close checks are maintained on dissolved oxygen at selected points in the Carrousel raceway so that an excess of oxygen exists throughout most of the distance. Balance is maintained so that a rather short anoxic area exists just upstream from the discharge weir. Since the system is receiving on the order of 250 g/m when in operation, and the Carrousel contains 380000 gallons, the amount added and discharged during any given minute is very small. The suspended solids are continiously returned to the Carrousel from the final clarifier, or wasted to the sludge holding tanks for a period each day, usually two to four hours. This is required to maintain the suspended solids concentration in the Carrousel at 7000 to 8000 mg./l.

B.O.D. removal is accomplished in the aerobic zones. So is nitrification, or conversion of nitrogenous material to nitrate. The purpose of the anoxic section is to provide for bacterial breakdown of nitrate to nitrogen, which is released to the atmosphere. Odor problems do not develop because of the stable sludge condition, as well as the short time period in the anoxic zone at any one time.

The final clarifier accomplishes removal of suspended solids and allows discharge of a clear, colorless, effluent to the receiving stream.

Results:

The table of analytical figures which follows speaks largely for itself. The degrees of removal of pollutants are given in the two bottom lines, primary and secondary. It is quite apparent after reviewing these results that this system is particularly effective in reducing polluted tannery wastewater to acceptable condition for surface disposition into a river or stream. Particularly please note the high degree of conversion of soluble nitrogenous compounds, not only ammonia, but soluble proteinaceous material into free nitrogen, which escapes as such into the atmosphere.

CHART I-C

DAILY REPORT - PRIMARY AND SECONDARY -- A.C. LAWRENCE LEATHER COMPANY DEMONSTRATION GRANT S804504

Date	Susp Solids S_1	S_2	S_3	S_4	B.O.D.5 Day S_1	S_2	S_4	NH-4-N S_1	S_4	TK-N S_1	S_2	S_4	NO_2 S_4	NO_3 S_4	FOG S_1	S_2	S_4	TOTAL CR S_1	S_2	S_4	ORTHO PO4 S_4
10-3	972	308	10470	80	600	192	3	31	0.7	71	40	3.6	.02	61	1563	134	6.6	100	17.5	1.1	1.3
10-4	954	180	10390	58	690	246	3	34	0.4	70	35	3.1	.01	53	439	104	2.8	85	6.5	0.8	0.65
10-5	732	228	8888	31	683	248	3	32	0.9	73	46	4.8	1.17	48	370	43	2.2	94	11.5	0.9	0.00
10-6	1078	236	10060	32	990	312	5	24	0.4	65	20	2	.01	22	452	25	2.8	100	12	0.6	1.0
10-7	676	118	9730	32	610	216	4	37	0.6	43	28	5	.76	3	265	5	0.8	100	3.5	0.2	0.25
10-11	1022	332	9850	60	870	300	4	34	0.5	79	19	2.8	.11	13	377	21	1.2	85	12	0.4	0.5
10-12	1104	410	9730	64	870	366	7	39	1.4	76	52	4.5	.64	9	454	82	0.8	95	28	0.4	0.12
10-13	1005	412	8669	13	790	347	6	40	2.7	81	56	5.6	.30	10	480	101	18	110	39	0.7	.25 Ortho
10-14	1004	252	10110	40	830	288	4	39	3.5	83	47	7.8	.00	8	415	9	2.8	100	6	0.5	00
10-5	608	316	9700	54	580	312	6	34	3.8	44	27	8.7	.30	5	218	61	1.8	110	27	0.8	00
10-18	1164	142	10620	66	720	252	3	10	0.9	62	32	3.9	.34	23	413	5	4.8	65	1.6	1.0	00
10-19	1080	96	8677	44	881	286	8	36	2.4	80	43	6.7	.00	9	542	24	7	104	4.7	1.5	0.66
Milligrams Per Liter																					
Ave.	945	252	9741	48	759	280	5	32	1.5	69	37	4.8	.30	22	499	51	7.9	96	14.1	0.7	0.5
% Removal P		73.4				63.1					46.3					89.7			85.2		
T				94.9			99.4		95.3			98.0					98.4			99.3	
Discharge Permit Requirements				50			50		1.5								15			0.5	

The Application of the System Described Herein to Chrome- Cattlehide and Vegetable Cattlehide Tanneries

In Section I 'Introduction' to this report it is pointed out that tanneries have been classified into seven categories to better understand the problems associated with each. Three of these categories relate to cattlehide tanneries full scale, meaning that hair removal, tanning, coloring and fatliquoring, and finishing are involved in each.
These are:

Category 1. Cattlehide - Pulped Hair - Chrome Tan
2. Cattlehide - Save Hair - Chrome Tan
3. Cattlehide - Non Chrome Tan

Very few, if any, cattlehide tanneries save hair and chrome tan. More and more the mode has become one of soak,wash and hair burn using strong sodium sulfide liquors, followed by reliming, and consolidated bate-pickle-tan in rapid sequence. Most tanners operating this way reclaim sulfide liquors using one of two or three methods, and all use some system to separate pulped hair solids from the waste stream before discharging to the sewage treatment system.

In a different, but similar manner, all vegetable tanners of real size, employ a hair save process. This system uses much less sulfide and produces a valuable by-product in the form of cattle hair, which has seen a resurgence in value and is now bringing almost as much per pound as it cost when purchased on the hide.

The net result of these on-plant activities has been to reduce high potential waste liquors to levels which are not so far distant as one might expect from those encountered at the subject shearling tannery. It has been stated that a shearling tannery is not a typical tannery since it is neither cattlehide, nor does it have a beamhouse, and therefore wastewater treatment technology transfer is not possible. Since A. C. Lawrence operates tanneries classified in categories 1,3 and 7, and company technicians are familiar with the details of all of the other categories, they have the capability of

recognizing the dissimilarities and parallels. Careful scrutiny divulges that there is not all that much difference.

In order to rather definitely establish the similarity we present the following table of typical analyses of wastewater from our own tanneries, all of which we consider to be more or less representative of complete tanning operations in their respective categories.

Typical Tannery Effluent Analyses

	Side Leather	Sole Leather	Shearling
	Category 1	Category 3	Category 7
Parameter	South Paris, Maine	Hazelwood, N.C.	Winchester, N.H.
B.O.D. 5	1630	686	840
Suspended Solids	2718	1080	1295
Total Solids	5620	5314	14000
Fats,Oils, Greases	580	201	443
pH	10.9	9.9	5.1
Chromium-Cr	187	-	109
NHz-N	14	73	32
TKN-N	126	179	78

All values - mg/l

Examination of this table shows that there is a remarkable similarity in the nature of the wastewater from each. The parameters are not the same, of course, but the significant differences are on the order, for the most part of about 2X. Total volume is considerably greater for the side leather tannery since this is a function of sheer bulk, but it seems remarkable that the pollution level in the wastewater from each is so close, gallon for gallon.

It seems in order then, to take the stance that this described system is in fact suitable for any tannery. We would add one recommendation, however, The primary clarification system is based upon flotation of solids. It seems reasonable to suggest that it would be most efficient to remove the heavy suspended solids usually present in cattlehide tannery wastewater by providing bottom sweeps

and sludge collection cavities in the surge tank. This would not add greatly to the orginal cost, and would remove the heavy solids at the most advantageous point.

With this recommendation we can say without reservation that a wastewater treatment plant, based upon the design principles, primary and secondary, as described herein, carefully engineered and operated, would appear to be capable of accomplishing the same removal and reduction of all parameters, and discharge a treated effluent to a receiving stream, or whatever destination with about the same degree of efficiency.